CLAIMS

1. A method for using global motion predictors (GMPs) in predictive motion estimation for the compression of video, the method comprising:

receiving video frames;

generating a set of global motion parameters for a current frame of video;

in response to the global motion parameters, generating GMPs for image blocks in the current frame;

estimating motion between the current frame and a reference frame;

subtracting reference blocks in the reference frame from image blocks in the current frame, leaving residual image blocks; and,

encoding the residual image blocks in a video stream.

2. The method of claim 1 wherein generating GMPs for image blocks in the current frame includes generating a global motion vector (V_{GM}) for each a×a image block as follows:

$$\underline{v}(x,y) = \underline{r}^{0} + \left(\frac{x}{H-a}\right)\underline{r}^{x} + \left(\frac{y}{V-a}\right)\underline{r}^{y} + \left(\frac{x}{H-a}\right)\left(\frac{y}{V-a}\right)\underline{r}^{xy}$$

where $\underline{r}^{0}$, $\underline{r}^{x}$, $\underline{r}^{y}$, and $\underline{r}^{xy}$ are defined as the following:

$$\underline{r}^{0} = \underline{v}^{00}$$
$$\underline{r}^{x} = \underline{v}^{H0} - \underline{v}^{00}$$
$$\underline{r}^{y} = \underline{v}^{0V} - \underline{v}^{00}$$
$$\underline{r}^{xy} = \underline{v}^{00} - \underline{v}^{H0} - \underline{v}^{0V} + \underline{v}^{HV}$$; and,

where $\underline{\upsilon}^{00}$, $\underline{\upsilon}^{H0}$, $\underline{\upsilon}^{0V}$, and $\underline{\upsilon}^{HV}$ represent the motion vectors of four a×a image blocks, at the four corners of the current frame having a size of $H \times V$.

3. The method of claim 2 wherein generating GMPs for image blocks in the current frame includes generating GMPs for 16×16 pixel image blocks.

4. The method of claim 1 further comprising:

generating local motion predictors (LMPs); and,

wherein estimating motion between the current frame and a reference frame includes estimating motion using the GMPs and the LMPs.

5. The method of claim 4 wherein estimating motion between the current frame and a reference frame includes using previously encoded information from a source selected from the group including temporarily distant reference frames and other image blocks in the current frame.

6. The method of claim 1 wherein generating a set of global motion parameters for a current video frame includes generating a set of global motion parameters for a current predictive (P) frame, considered with respect to a previously encoded frame.

7. The method of claim 1 wherein generating a set of global motion parameters for a current video frame includes generating a

set of global motion parameters for a current bidirectional (B) frame, considered with respect to previous encoded frames selected from a group including frames occurring before the current frame and frames occurring after the current frame.

8. The method of claim 7 wherein generating GMPs for image blocks in the current B frame includes deriving the GMPs from a V_{GM} calculated for the corresponding image block in a previously encoded P frame.

9. The method of claim 1 wherein generating a set of global motion parameters for a current frame of video includes generating global motion parameters between the current frame and a first reference frame;

wherein generating GMPs for image blocks in the current frame includes scaling GMPs in response to the temporal difference between a first reference and the current frame.

10. The method of claim 9 wherein generating global motion parameters includes generating global motion parameters between the current frame and a first reference frame having a temporal difference T_B;

wherein generating GMPs for image blocks in the current frame includes:

generating a global motion vector (V_{GM}) with respect to a second reference frame, having a temporal difference T_A from the current frame; and,

scaling the GMPs as follows:

$$GMP = V_{GM} \cdot (T_B/T_A).$$

11. The method of claim 9 wherein generating GMPs for image blocks in the current frame includes generating GMPs for image blocks in a B frame; and,

wherein scaling GMPs in response to the temporal difference between the first reference and current frames includes scaling the GMPs in response to a first reference frame selected from the group including a frame occurring before the current frame and a frame occurring after the current frame.

12. The method of claim 5 wherein using previously encoded information from other image blocks in the current frame includes:

finding the GMPs for a first image block in the current frame; and,

using the first image block GMPs to estimate motion for a second image block in the current frame.

13. The method of claim 4 wherein generating LMPs includes generating LMPs for a current P frame as follows:

a Motion Vector Prediction (MVP) as specified by the encoded video stream standard (LP1);

a zero motion vector (LP2);

a motion vector used by a previously tested block type in the current frame, at the same position, temporally scaled, and when the current block is a bottom field block, an additional motion vector used by a top field block in the same position (LP3);

a motion vector of the left neighboring block, scaled for the current reference picture (LP4);

a motion vector of the upper neighboring block, scaled for the current reference picture (LP5);

a motion vector of the same position in the previously encoded reference frame, temporally scaled for the current reference picture, and scaled for differences in mode selected from the group including field and frame modes (LP6);

a motion vector of a right neighboring block in the previously encoded reference frame, temporally scaled, and scaled for differences selected from the group including field and frame modes (LP7); and,

a motion vector of a lower neighboring block in the previously encoded reference frame, temporally scaled, and scaled for differences selected from the group including field and frame modes (LP8).

14. The method of claim 4 wherein generating LMPs includes generating LMPs for a current B frame as follows:

a forward Motion Vector Prediction (MVP) relative to a first reference frame in a forward reference list, selected from a group

including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB1);

a backward MVP relative to a first reference frame in a backward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB2);

a forward zero motion vector relative to the first reference frame in the forward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB3);

a backward zero motion vector relative to the first reference frame in the backward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB4);

a motion vector used by previously tested block type in the current frame, at the same position, selected from the group including backward and forward motion vectors, the motion vector selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB5);

a motion vector of the left neighboring block, selected from the group including backward and forward motion vectors (LB6);

a motion vector of the upper neighboring block, selected from the group including backward and forward motion vectors (LB7);

a motion vector of the same position in the first reference frame in the forward reference list, scaled for differences in mode selected from the group including field and frame modes (LB8);

a scaled LB8 motion vector pointing to the first reference picture in the forward reference list (LB9);

a scaled LB8 motion vector pointing to the first reference picture in the backward reference list (LB10);

a motion vector of the same position in the first reference frame in the backward reference list, scaled for differences in mode selected from the group including field and frame modes (LB11); and,

a motion vector of the same position in the first reference frame in the backward reference list, scaled for differences in mode selected from the group including field and frame modes, and further scaled to point to the first reference picture in the backward reference list (LB12).

15. The method of claim 8 wherein generating global motion parameters includes generating global motion parameters between a previously encoded P frame and a first reference frame having a temporal difference T_A;

wherein generating GMPs for image blocks in the current frame includes generating a global motion vector (V_{GM}), scaled with respect to a second reference frame, having a temporal difference T_B from the current frame as follows:

$$GMP = V_{GM} \cdot (T_B/T_A).$$

16. The method of claim 4 wherein generating a set of global motion parameters for a current video frame includes generating a set of global motion parameters for a current B frame;

wherein estimation motion includes simultaneously selecting a reference frame and a local motion predictor type.

17. A system for using global motion predictors (GMPs) in predictive motion estimation for the compression of video, the system comprising:

a variable length coder (VLC) having an interface to receive transformed video frame residuals and an interface to supply an encoded video stream;

a global motion parameter estimator (GMPE) having an interface to accept a current video frame, an interface to accept a first reference frame, and an interface to supply global motion parameters calculated in response to comparing the current frame to the first reference frame;

a block motion decision unit having an interface to receive the global motion parameters, the block motion decision unit calculating GMPs in response to comparing image blocks in the current frame to reference blocks in a second reference frame, and supplying motion prediction blocks at an interface; and,

a summing circuit having an interface to accept the current frame, an interface to accept the motion prediction blocks, and an interface to supply residual image blocks for coding, as a result of subtracting the motion prediction blocks from image blocks in the current frame.

18. The system of claim 17 further comprising:

a local motion estimator having an interface to accept the current frame and an interface to accept the second reference frame, and an interface to supply local motion predictions (LMPs) in response to comparing image blocks in the current frame and reference blocks in the second reference frame; and,

wherein the block motion decision unit has an interface to accept the LMPs and supplies motion prediction blocks in response to the GMPs and the LMPs.

19. The system of claim 17 wherein the block motion decision unit generates a global motion vector (VGM) for each a×a image block as follows:

$$\underline{v}(x,y) = \underline{r}^0 + \left(\frac{x}{H-a}\right)\underline{r}^x + \left(\frac{y}{V-a}\right)\underline{r}^y + \left(\frac{x}{H-a}\right)\left(\frac{y}{V-a}\right)\underline{r}^{xy}$$

where $\underline{r}^0$, $\underline{r}^x$, $\underline{r}^y$, and $\underline{r}^{xy}$ are defined as the following:

$$\begin{aligned}
\underline{r}^0 &= \underline{v}^{00} \\
\underline{r}^x &= \underline{v}^{H0} - \underline{v}^{00} \\
\underline{r}^y &= \underline{v}^{0V} - \underline{v}^{00} \\
\underline{r}^{xy} &= \underline{v}^{00} - \underline{v}^{H0} - \underline{v}^{0V} + \underline{v}^{HV}
\end{aligned}$$; and,

where $\underline{v}^{00}$, $\underline{v}^{H0}$, $\underline{v}^{0V}$, and $\underline{v}^{HV}$ represent the motion vectors of four a×a image blocks, at the four corners of the current frame having a size of $H \times V$.

20. The system of claim 19 wherein the block motion decision unit generates GMPs for 16×16 pixel image blocks.

21. The system of claim 18 wherein the block motion decision unit supplies motion prediction blocks in response to using previously encoded information from a source selected from the group including temporarily distant reference frames and other image blocks in the current frame.

22. The system of claim 17 wherein the GMPE generates a set of global motion parameters for a current predictive (P) frame, considered with respect to a previously encoded frame.

23. The system of claim 17 wherein the GMPE generates a set of global motion parameters for a current bidirectional (B) frame, considered with respect to previous encoded frames selected from a group including frames occurring before the current frame and frames occurring after the current frame.

24. The system of claim 23 wherein the block motion decision unit derives the GMPs from a V_{GM} calculated for the corresponding image block in a previously encoded P frame.

25. The system of claim 17 wherein the GMPE generates a set of global motion parameters using a first reference frame having a temporal difference (T_B) from the current frame; and,

wherein the block motion decision unit scales GMPs in response to the temporal difference between the first reference frame and the current frame.

26. The system of claim 25 wherein the block motion decision unit generates a global motion vector (V_{GM}) with respect to a second reference frame, having a temporal difference T_A from the current frame, and scales GMPs as follows:

$$GMP = V_{GM} \cdot (T_B/T_A).$$

27. The system of claim 25 wherein the block motion decision unit generates GMPs for image blocks in a B frame, and scales GMPs in response to a first reference frame selected from the group including a frame occurring before the current frame and a frame occurring after the current frame.

28. The system of claim 21 wherein the block motion decision unit finds the GMPs for a first image block in the current frame, and uses the first image block GMPs to estimate motion for a second image block in the current frame.

29. The system of claim 21 wherein the local motion estimator generates LMPs for a current P frame as follows:

a Motion Vector Prediction (MVP) as specified by the encoded video stream standard (LP1);

a zero motion vector (LP2);

a motion vector used by a previously tested block type in the current frame, at the same position, temporally scaled, and when the current block is a bottom field block, an additional motion vector used by a top field block in the same position (LP3);

a motion vector of the left neighboring block, scaled for the current reference picture (LP4);

a motion vector of the upper neighboring block, scaled for the current reference picture (LP5);

a motion vector of the same position in the previously encoded reference frame, temporally scaled for the current reference picture, and scaled for differences in mode selected from the group including field and frame modes (LP6);

a motion vector of a right neighboring block in the previously encoded reference frame, temporally scaled, and scaled for differences selected from the group including field and frame modes (LP7); and,

a motion vector of a lower neighboring block in the previously encoded reference frame, temporally scaled, and scaled for differences selected from the group including field and frame modes (LP8).

30. The system of claim 21 wherein the local motion estimator generates LMPs for a current B frame as follows:

a forward Motion Vector Prediction (MVP) relative to a first reference frame in a forward reference list, selected from a group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB1);

a backward MVP relative to a first reference frame in a backward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB2);

a forward zero motion vector relative to the first reference frame in the forward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB3);

a backward zero motion vector relative to the first reference frame in the backward reference list, selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB4);

a motion vector used by previously tested block type in the current frame, at the same position, selected from the group including backward and forward motion vectors, the motion vector selected from the group including a frame coding MVP, a same-parity field coding MVP, and an opposite-parity field coding MVP (LB5);

a motion vector of the left neighboring block, selected from the group including backward and forward motion vectors (LB6);

a motion vector of the upper neighboring block, selected from the group including backward and forward motion vectors (LB7);

a motion vector of the same position in the first reference frame in the forward reference list, scaled for differences in mode selected from the group including field and frame modes (LB8);

a scaled LB8 motion vector pointing to the first reference picture in the forward reference list (LB9);

a scaled LB8 motion vector pointing to the first reference picture in the backward reference list (LB10);

a motion vector of the same position in the first reference frame in the backward reference list, scaled for differences in mode selected from the group including field and frame modes (LB11); and,

a motion vector of the same position in the first reference frame in the backward reference list, scaled for differences in mode selected from the group including field and frame modes, and further scaled to point to the first reference picture in the backward reference list (LB12).

31. The system of claim 17 wherein the GMPE generates a set of global motion parameters for a current B frame; and,

wherein the block motion decision unit simultaneously selects a reference frame and a local motion predictor type.

32. The system of claim 24 wherein the GMPE generates global motion parameters between a previously encoded P frame and a first reference frame having a temporal difference T_A; and,

wherein the block motion decision unit generating GMPs for image blocks in the current frame by generating a global motion vector (V_{GM}) scaled with respect to a second reference frame, having a temporal difference T_B from the current frame as follows:

$$GMP = V_{GM} \cdot (T_B/T_A).$$